wide variety of probability of distribution curve shapes may be utilized in any of the steps disclosed herein.

After generating smoothed probability function **51**, processing system **32** may multiply the activation signal **53** by the initialization probability function **49** to generate a posteriori probability distribution **55**. A posterior probability distribution **55** is illustrated under the "Beat 1" column of FIG. **11***c*. After generating a posterior probability distribution **55**, the greatest peak **43** of a posterior probability distribution **55** is selected as the true activation time for beat 1 of the cardiac cycle.

After selecting peak **43**, processing system **32** may perform a regularization step. The regularization step may include multiplying fixed window **45** by a posterior probability distribution **55**. In some embodiments, the regularization step may reduce the effects of adjacent beats, which may otherwise accumulate over subsequent steps of the statistical algorithm.

Lastly, a posterior probability **55** is time shifted one cardiac cycle (the steps of generation having been disclosed above) and is used as the initialization probability distribution **55** of the subsequent beat in the cardiac cycle. The subsequent beat is illustrated in FIGS. **11***a*-**11***c* under the "Beat 2" column. At this point, the statistical algorithm repeats itself, starting with smoothing the initialization probability distribution **55**. As the process repeats itself, it selects true activation times for each beat. However, as stated above, the activation times chosen for a given beat are influenced by prior data and probability distributions derived from previous beats. In FIG. **11***c*, for example, activation time **47** has been influenced by prior data corresponding to beat 1. Similarly, activation time **59** has been influenced by prior data corresponding to both beat 1 and beat 2 (as beat 2 has been influenced by beat 1). In both cases, activation times **47** and **59** have been chosen as the greatest peak on the posterior distributions for beats 2 & 3, respectively.

After activation times (and/or corresponding fiducial points) have been identified, it may be desirable to display one or more processed outputs. For example, in some embodiments in may be desirable to compare and categorize the derived activation times of the collected signals. As described above, it may be desirable to display relative activation times in an activation map. An example activation map **99** is shown in FIG. **10**. FIG. **10** displays activation times corresponding to the sixty-four electrodes **24** on structure **20**. However, while the numerical values may be useful, in practice the data may utilize a color scheme, patterns, or the like to convey the information.

It should be understood that processing system **32** may selectively eliminate some of the collected signals before performing the techniques and/or embodiments disclosed herein. For example, it may be beneficial to eliminate signals collected by electrodes that are not in electrical contact, or in poor electrical contact, with excitable cellular tissue of the heart. Such signals may not provide useful information and can skew results of the above described techniques. Further, processing system **32** may eliminate collected signals that do not cross a threshold power level and/or may eliminate collected signals that display a threshold amount of noise.

Alternatively, instead of eliminating collected signals that are not providing useful information, processing system **32** may instead interpolate the value of any signal which is not otherwise providing desirable information. Processing system **32** may utilize the interpolated data (e.g. signal data) to better calculate, determine or generate useful processed data and/or smooth, refine, or present processed data in a more desirable manner.

In at least some of the embodiments described above the disclosed methods assume analysis of sensed, collected, measured and transmitted electrical cellular data occurring during a single heartbeat and/or cardiac pulse. However, it is contemplated that any of the disclosed methods may be implemented across multiple beats or cardiac pacing time intervals. Further, data collected over multiple heart beats may be analyzed using statistical methodologies and applied to the disclosed methods. For example, activation times may be collected over a series of heart beats and/or pulses. A statistical distribution of the collected activation times may be calculated, analyzed and incorporated into disclosed methods.

It should be understood that this disclosure is, in many respects, only illustrative. Changes may be made in details, particularly in matters of shape, size, and arrangement of steps without exceeding the scope of the invention. This may include, to the extent that it is appropriate, the use of any of the features of one example embodiment being used in other embodiments. The invention's scope is, of course, defined in the language in which the appended claims are expressed.

What is claimed is:

1. A system for mapping the electrical activity of the heart, the system comprising:

a processor, the processor configured to:

sense a plurality of signals with a plurality of electrodes positioned within the heart;

generate, based at least in part on the sensed plurality of signals, an alternate signal for each one of the plurality of signals, wherein each alternate signal corresponds to one of the plurality of signals, and wherein generating the alternate signal for each one of the plurality of signals includes determining a dominant frequency for the plurality of signals;

determine a fiducial point on each alternate signal; and

determine, based at least in part on each determined fiducial point, an activation time in each corresponding one of the plurality of signals.

2. The system of claim **1**, wherein determining, based at least in part on each determined fiducial point, an activation time in each corresponding one of the plurality of signals comprises determining a timing associated with each fiducial point as the activation time for each corresponding one of the plurality of signals.

3. The system of claim **2**, wherein determining, based at least in part on each determined fiducial point, an activation time in each corresponding one of the plurality of signals comprises:

identifying, based at least in part on a timing associated with each fiducial point, a window in each corresponding one of the plurality of signals; and

for each of the plurality of signals, determining an activation time within the identified window.

4. The system of claim **3**, wherein determining an activation time within the identified window comprises determining the timing of the maximum negative derivative in the identified window as the activation time for each of the plurality of signals.

5. The system of claim **4**, wherein determining an activation time within the identified window comprises determining the timing of a zero-crossing in the identified window as the activation time for each of the plurality of signals.

6. The system of claim **5**, wherein if no zero-crossing occurs within an identified window, determining the timing associated with the fiducial point as the activation time for the corresponding one of the plurality of signals.

7. The system of claim **6**, wherein a width of the window is user defined.